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Telehealth-guided home-based maggot debridement therapy for chronic complex wounds: Peri- and post-pandemic potential

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Abstract

Patients with complex chronic lower extremity wounds require a great deal of interaction with outpatient and inpatient services. Paradoxically, these are the very patients that, because of their chronic comorbidities, are at greatest risk for COVID-related morbidity and mortality. Disinfected *Phaenicia* (*Lucilia*) *sericata* (Medical Maggots; Monarch Labs, Irvine, California) were applied in a standardised fashion by a home-health nurse with direct monitoring, guidance, and collaboration of the attending surgeon. A family member was able to change the outer dressing daily based on normal wound exudate. The inner maggot debridement therapy (MDT) dressing was changed at 2 days showing dramatic reduction in necrotic tissue, elimination of profound malodor, and no evidence of local or advancing infection. The entire initial telehealth-guided application took approximately 20 minutes. The first telehealth-guided MDT dressing change took 14 minutes. We used an artificial-intelligence-based algorithm to measure changes in wound characteristics. At day 0, 46% of the total surface area was covered in malodorous black, necrotic tissue. The first dressing change saw an elimination in assessed malodor with necrotic tissue constituting 14% of total surface area. The second dressing change at 5 days showed a greater than 99% reduction in necrotic tissue. This manuscript constitutes what we believe to be the first telehealth-guided MDT conducted during a resource-limited peri-pandemic period. We believe that MDT, which is an extension of efforts regularly performed in clinic and hospital, may have the potential to reduce resource usage while potentially improving care and quality of life for people with limb and life-threatening complications of diabetes and other chronic diseases.

KEYWORDS

debridement, outpatient, telemedicine

1 | INTRODUCTION

Chronic wounds remain complex and costly complications of diabetes.[1-3] In fact, they constitute some of the most common reasons for hospital admission and years lived with disability, worldwide.[3-6] Not only are these patients, with their multiple comorbidities, at greatest risk for morbidity and mortality from COVID-19,[7,8] but their frequent clinic visits and hospitalizations put them and their care providers at increased risk of acquiring COVID-19 and other communicable diseases.[7,8]

A cornerstone of wound healing involves good quality surgical debridement.[9-11] Unfortunately, this requires instrumentation, expertise, and supplies that are typically found in hospitals and clinics, where the people that may benefit most are at greatest risk of acquiring serious infections/contagious diseases. For millennia, people have used maggot debridement therapy (MDT) in various capacities to clean wounds.[12,13] These larvae appear to improve healing and extend antibiotic-free days in our highest risk patients.[14-16] The US Food and Drug Administration (FDA) cleared the use of maggots as a medical device in 2004, and both the American Medical Association and Centers for Medicare and Medicaid have reimbursement guidelines and current procedural terminology (CPT) codes for maggot therapy.[17]

The use of MDT would seem ideally suited under the right conditions to extend care into the home.[18] With the advent of high-quality, low-cost, ubiquitous access to telehealth and video conferencing via smartphone, one could potentially allow physicians and surgeons to actively liaise with specialist visiting clinicians to use this technique with more confidence and efficacy.[19,20] The purpose of this manuscript was to describe what we believe to be the first documented use of telehealth-guided MDT for high-risk patients with complex tissue loss.

Key Messages

- patients with chronic lower extremity wounds often require debridement to promote optimal healing; however, they are at high-risk for morbidity and mortality from communicable disease
- we performed what we believe to be the first telehealth-guided maggot debridement therapy by a home-health nurse with direct monitoring, guidance, and collaboration of the attending surgeon
- at the first dressing change, necrosis was reduced from 46% to 14% and malodor was eliminated. At second dressing change, necrotic tissue was reduced to less than 1% of the wound area

TABLE 1 Application of maggot therapy in seven simple steps

If commercially available maggot therapy dressings are not available or appropriate, dressings can be constructed in the following method, based on Armstrong et al.[7,8] Always assemble the necessary materials in advance. Dressings should be left on for no more than 48 to 72 hours.
1 Manual sharp debridement beforehand, whenever feasible. If sharp debridement is not feasible and if eschar is present, apply autolytic dressing for 24 to 48 hours beforehand, to soften the eschar while waiting for the maggots to arrive.
2 Cleanse the wound of any ointments (which can block the maggots' breathing holes) or toxic chemicals and disinfectants.
3 Coat the peri-wound skin with a skin protectant.
4 Create a maggot barrier by applying a 1 to 2 cm margin of hydrocolloid or waterproof tape (ie, Microfoam; 3M, St. Paul, Minnesota; or Hypafix; MSN Medical, Charlotte, North Carolina) to the periphery of the wound. Coat the barrier with a layer of adhesive (Nu-Hope Adhesive; Nu-Hope Industries, Mission Hills, California; LeGlu; Monarch Labs, Irvine, California; Hollister Medical Adhesive Spray; Hollister, Libertyville, Illinois).
5 Transfer the medicinal maggots to the wound. If the larvae come as maggot-impregnated gauze, lay the gauze over the wound bed. The dose is 5 to 10 larvae/cm^2. Do not count the maggots; measure the gauze. For example, if the gauze contains twice the number of maggots as are required for the size of the wound, then cut and apply only half of the maggot-impregnated gauze.
6 Quickly cover the wound with the net fabric cover, and fasten to the sticky hydrocolloid or tape borders. Large pores in the fabric will better facilitate oxygen to enter the dressing and liquefied necrotic tissue to drain out, but under no circumstances should the pores be larger than 160*u*, or else the maggots will escape. Polyester net or nylon stockings are effective and inexpensive. A second layer of adhesive should be applied where the net overlies the first adhesive layer. The two layers will bond through the fabric pores. Cover this second layer of adhesive with a strip of water-resistant tape, to prevent the adhesive from sticking to anything else.
7 Now that the maggots have been "caged" over the wound bed, a light absorbent layer should be applied to wick and contain the wound drainage. A few gauze pads or roll gauze will usually suffice. It should be changed at least twice daily and whenever it is soiled, for otherwise, the wet gauze covering will reduce the influx of oxygen to the maggots.

FIGURE 1 Telehealth-guided maggot debridement therapy: Guidance and workup during dressing change

FIGURE 2 Maggot debridement therapy nylon stocking dressing in place at home. The nylon stocking primary dressing holds the larvae in place. The outer dressing can be changed with plain gauze as needed by the family

2 | METHODS AND RESULTS: CASE REPORT

A 68-year-old man with type 2 diabetes, peripheral artery disease, congestive heart failure, and chronic kidney disease presented for care by our high-risk limb preservation service. Following a lower extremity revascularization and guillotine transmetatarsal amputation for forefoot gangrene, he had a residual 9 × 5 cm^2 forefoot wound. This wound underwent one additional intraoperative revision to cover the bone with viable intrinsic muscle and a biologic dressing (Integra Bilayer; Integra LifeSciences, New Jersey) as well as negative pressure wound therapy (VAC; 3M, San Antonio, Texas). After removal of the biologic showed patches of healthy granulation tissue, approximately 45% of the wound was developing necrotic tissue failing to thrive. The patient's need for further debridement now coincided directly with the COVID restrictions on operating room capacity and clinical care. The increased risks for this patient were weighed against the benefits of in-clinic or intraoperative debridement. A third option was chosen to balance risk with therapeutic reward: home-based, telehealth-guided MDT. Disinfected *Phaenicia* (*Lucilia*) *sericata* maggots (Medical Maggots; Monarch Labs, Irvine, California) were applied in a standardised seven-step fashion[21] (Table 1) by a home-health nurse with direct monitoring, guidance, and collaboration of the attending surgeon (Figure 1). A family member was able to change the outer dressing daily based on normal wound exudate (Figure 2). The inner MDT dressing was changed at 2 days showing dramatic reduction in necrotic tissue, elimination of profound malodor, and

FIGURE 3 Telehealth-guided maggot debridement therapy: Progress from two dressing changes over 5 days. Guillotine transmetatarsal amputation before, A, and 48 hours after, B, first MDT application. Note larvae and gauze, C, prior to removal showing mature larvae and, D, second dressing change on MDT day 5. MDT, maggot debridement therapy

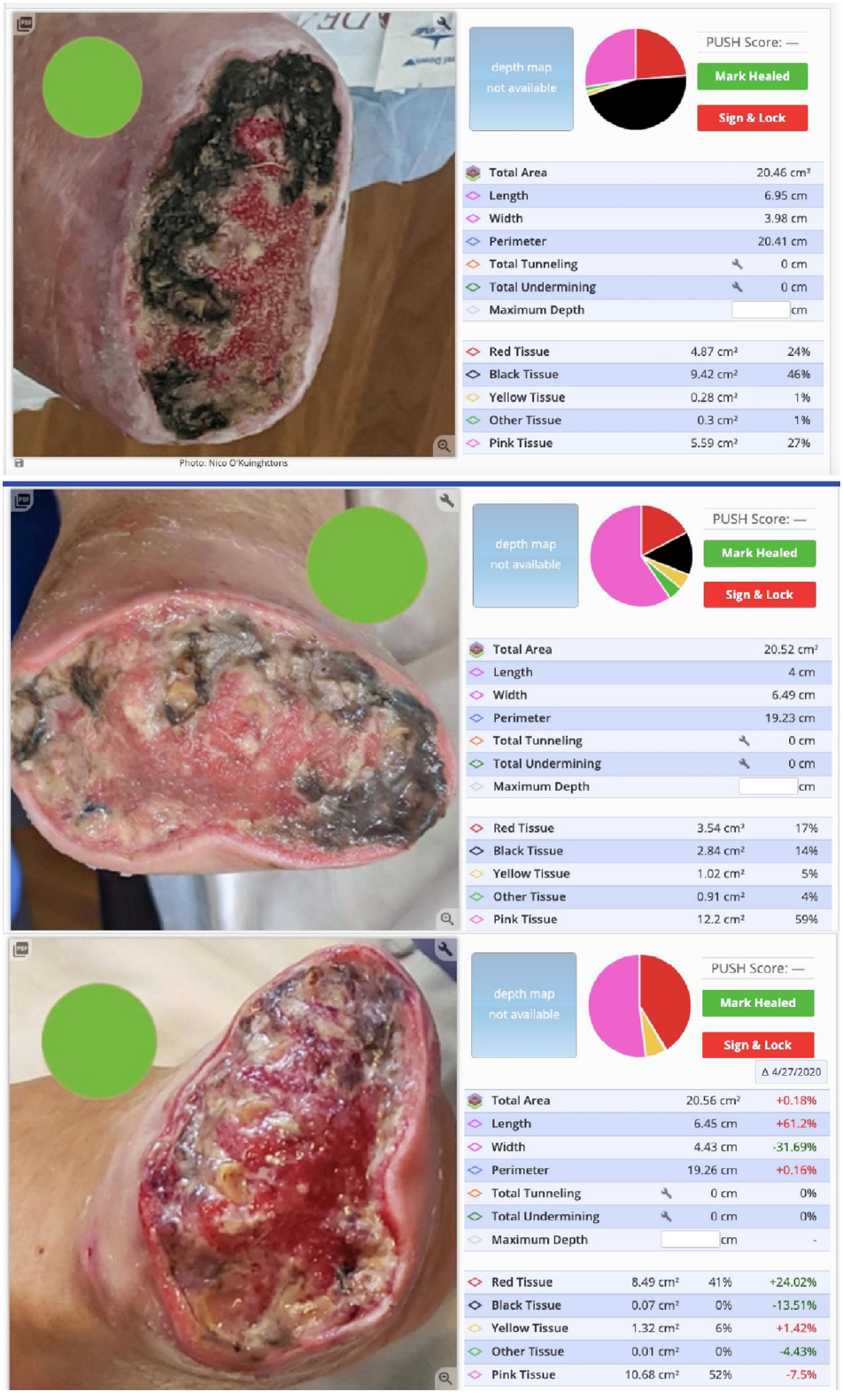

FIGURE 4 Quantitative assessment of wound characteristics. Reduction in necrotic (black) tissue from 46% of total surface area at baseline to 14% at day 2 to less than 1% on day 5 of MDT. MDT, maggot debridement therapy

no evidence of local or advancing infection (Figure 3). The entire initial telehealth-guided application took approximately 20 minutes. The first telehealth-guided MDT dressing change took 14 minutes. We used Tissue Analytics (Tissue Analytics, Baltimore, Maryland) to quantify change in wound characteristics. At day 0, 46% of the total surface area was covered in malodorous black, necrotic tissue. The first dressing change saw a complete elimination of assessed malodor with necrotic tissue constituting 14% of total surface area.

TABLE 2 Advantages of telemedicine-guided maggot debridement therapy

1	Debridement efficacy, demonstrated by multiple studies.
2	Safe enough for nurses or even patients to apply, under physician guidance.
3	Decreased usage of physical resources (faster debridement means fewer dressings, antibiotics, and surgical equipment).
4	Decreased human resource usage (fewer office visits, less time by highly skilled clinicians).
5	Can be performed in settings where there is no electricity or running water.
6	Can be performed with clean, not sterile dressing materials.
7	Maintenance debridement, if needed, can keep the wound base clean and healthy until a definitive surgical closure is feasible.
8	Same, simple method of application and materials, regardless of wound aetiology or characteristics (size and drainage).
9	In laboratory studies, maggot therapy has been shown to disrupt established biofilm and inhibit formation of new biofilm.[22-25]

TABLE 3 Other populations and situations that could benefit from telemedicine-guided maggot debridement therapy

1	Home-bound patients
2	Patients with limited access to power and transportation Rural, secluded communities without nearby access to advanced wound care therapy Disaster areas
3	Institutionalised patients Long-term care centres Incarcerated

The second dressing change at 5 days showed a greater than 99% reduction in necrotic tissue. These measurements are illustrated in Figure 4.

3 | DISCUSSION

This manuscript constitutes what we believe to be the first telehealth-guided MDT conducted during a resource-limited peri-pandemic period. We believe that this technique, which is an extension of efforts regularly performed in clinic and hospital, may have the potential to dramatically reduce resource usage (Table 2) while potentially improving care and quality of life for people with limb and life-threatening complications of diabetes and other chronic diseases. These methods should be applicable to a wide variety of resource-limited situations (Table 3).

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Maggots are an FDA-cleared treatment, reimbursable by insurance.

CONFLICT OF INTEREST

Ronald Sherman declares the following conflicts of interest: He is Co-Founder and Laboratory Director of Monarch Labs (Irvine, CA), which produces medicinal maggots and other medicinal animals. To minimize conflicts of interest, Dr. Sherman is not compensated for his work at Monarch Labs nor his work for the BTER Foundation. His wife, however, is paid a salary for working day and night at the lab. The remaining authors declare no conflicts of interest.

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